Formation Flying for External Occulters

Completed Technology Project (2015 - 2016)

Project Introduction

In support of NASA's Exoplanet Exploration Program and the Technology Development for Exoplanet Missions (TDEM) opportunity, this proposal, our fourth in the TDEM program, describes the next essential steps in the technology advancement of an external occulter for starlight suppression. Our first TDEM demonstrated the viability of our petal design and manufacturing approach, showing that a petal can be made with the shaped controlled to an accuracy that meets the requirements for better than 10^(-10) contrast. Our second showed that our deployment approach meets the requirements on deployed petal positioning. Our third, and current, TDEM is upgrading the laboratory to demonstrate better than 10^(-10) suppression in an experiment scaled from typical flight values (at constant Fresnel number). This will validate the optical modeling used to predict occulter performance. The already-demonstrated petal shape performance and deployment accuracy satisfy key elements in technology development for exo-Earth detection and characterization. Starshades can image extrasolar earths in the habitable zone without resorting to exotic technologies and placing extraordinary requirements on a space observatory. For this fourth TDEM we begin the verification of precision formation flying between the starshade and telescope by developing algorithms and instrumentation that will be tested in the laboratory. This effort will 1) develop a breadboard formation alignment sensor and demonstrate that it achieves the necessary precision in a hardware testbed, 2) mature formation flying guidance, estimation/navigation, and control algorithms that utilize the formation alignment sensor to fuel-optimally meet the 1-m class lateral alignment requirement and that reliably and autonomously transition from retargeting to observation, and 3) demonstrate simultaneous closed-loop formation alignment and starlight suppression in a scaled hardware-in-the-loop occulter testbed. The hardware-in-the-loop demonstrations will use a breadboard instrument with both a 3-band science camera and the guide camera for the formation alignment sensor. In these demonstrations, the formation flying algorithms will use the feedback signal from breadboard formation alignment sensor, thereby maturing the formation flying for external occulters to TRL 4 while showing in hardware that the necessary starlight suppression is achieved by taking science images.

Anticipated Benefits

Decadal Survey Missions

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Strategic Astrophysics Technology

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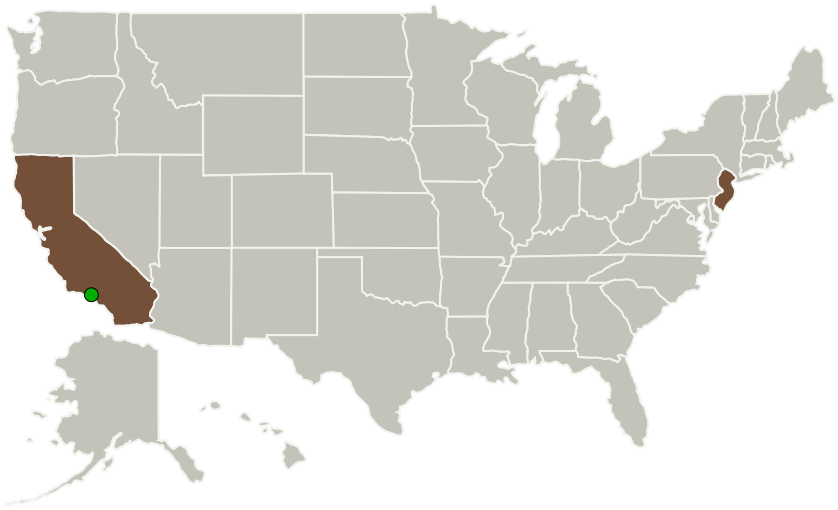
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
California Institute of Technology(CalTech)	Supporting Organization	Academia	Pasadena, California
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California
Princeton University	Supporting Organization	Academia	Princeton, New Jersey

Primary U.S. Work Locations	
California	New Jersey

Project Management

Program Director:
Mario R Perez

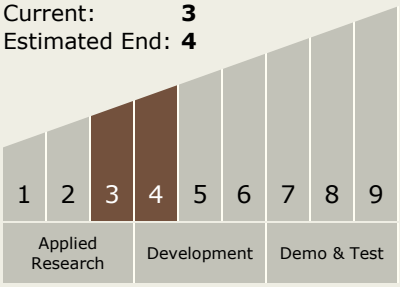
Program Manager:
Mario R Perez

Principal Investigator:
N Jeremy Kasdin

Co-Investigator:
Jeffrey Friedland

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **4**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.2 Observatories
    - TX08.2.3 Distributed Aperture

Target Destination

Outside the Solar System